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An alternative approach to improve mathematics performance of fourth graders: GA's in mathematics education

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Abstract

This study is suggesting an alternative approach to improve the mathematics performance of fourth graders by using Genetic Algorithm (GA), which is a global optimization methods used in almost all branches of science. The mathematics performance of fourth graders in North Cyprus region was investigated. The results obtained showed that they are poor mainly in non-routine story problems. The proposed method here was developed as a web based solution. First stage of the method is to check the performances of the students in six different items; numbers, operations, and story problems both in routine and non-routine forms. The questions used in the tests will be selected from a library of questions in the mentioned six possible groups by GA principle. The results from the tests will be a feed-back to the teachers about the student performances and also their abilities in the mentioned items. Then according to the test results the teacher may need to revise his/her teaching method followed in the class. If necessary, the tests can be repeated several times until the class (and individuals) reaches to a reasonable performance. The second stage is mainly to investigate the performance of the students in story problems with 'problem posing' principle.

Keywords: Fourth graders; mathematics performance; mathematical operations; numbers; story problems; routine; non-routine; Genetic Algorithms

1. Introduction

Several publications emphasize solving non-routine mathematics problems as good indicators of mathematics performance (e.g. National Council of Teachers of Mathematics, 1989; 1991; 2000). On the other hand, it is also well known that standardized test-driven instructional approach affects the mathematical performance of students. Experiments have already demonstrated that students who spent more time on test taking skills led to memorizing procedures and cuing on surface attributes of problems (Cankoy & Tut, 2005). Specifically, in North Cyprus region this is the case where the teaching methods are based on test-driven approach, instead of teaching principles. As mentioned in Cankoy and Tut (2005), and Tut(2006), memorizing instead of learning (teaching) principles is a main obstacle in mathematics education of fourth graders who are trying to get prepared for college entrance examination. But, as expected the lack of knowledge in mathematics principles affects the mathematics performances of students at higher grades.

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2. Methodology

Starting out with the findings of the mentioned works, the following idea is to suggest a new, alternative method to improve the mathematics performance of fourth graders. The method contains also Genetic Algorithm, GA, approach which is supported by database management systems (DBMS) (Connolly & Ramakrishnan, 2010). The suggested method which involves two main actions is assuming that the targeted fourth graders have no problem about reading and/or understanding given sentences from their language.

The first phase of the method is to check the mathematics performance of the fourth graders in six different types of items; numbers, operations, and story problems both in routine and non-routine forms. The questions that will be used in the tests are kept in a library located in a database. For each category different papers can be prepared as well as a paper with mixed items from categories. From the test results teachers will be able to see the performance of the students. If the performance of the students in the group (class) are not good enough then the teacher of the group may need to revise the teaching method followed in the class while teaching the tested category. From the test results the teacher will also be able to see the performance of each student. So these students with poor performance may be managed individually to reach the desired performance in the category. This is also obvious that after correcting the performance and understandings of students (and class) it is possible to recheck by applying another test(s) from the same category. Here, while repeating the tests the updated test questions will be selected by Genetic Algorithm (GA) principle which aims to reach optimum fitness function values that is to say the performance will be optimum.

The second phase of this study is mainly to investigate the performance of the fourth graders in story problems with 'problem posing' approach. A sentence of a word problem suitable for the grade is selected from the library. Words of the sentence are permuted (mixed) randomly. Then the students are asked to construct a meaningful sentence. If the sentence is correct the student will be asked to solve it. If the answer is correct then another question will be supplied, again from the library. But, if the constructed sentence is not meaningful then the student will be asked to correct it. These trials can be repeated for a predefined number of times. If it is again not correct the form or type of mistakes can be observed by the instructor such that the student may need some help about his/her language.

Note that in either stage of this study if the student's answer is not correct after enough no of tries the correct answer will be provided to the student by the system and supplying another question.

3. Database Implementation

As mentioned in the previous section the system involves a database. The database keeps test bank of qustions, teacher accounts, test papers, students' information, results of the tests. These modules are all administered by an administrator who manages also account profiles of the users, teachers and the students. The overall solution is a web-based solution and the tests are performed on computer terminals in well equiped laboratories.

The following use case and sequence diagrams generally pictures out the overall system. Where use case diagram models the interactions between a system's clients and the system, and sequence diagram models the interactions among objects in the system by emphasizing when interactions occur.

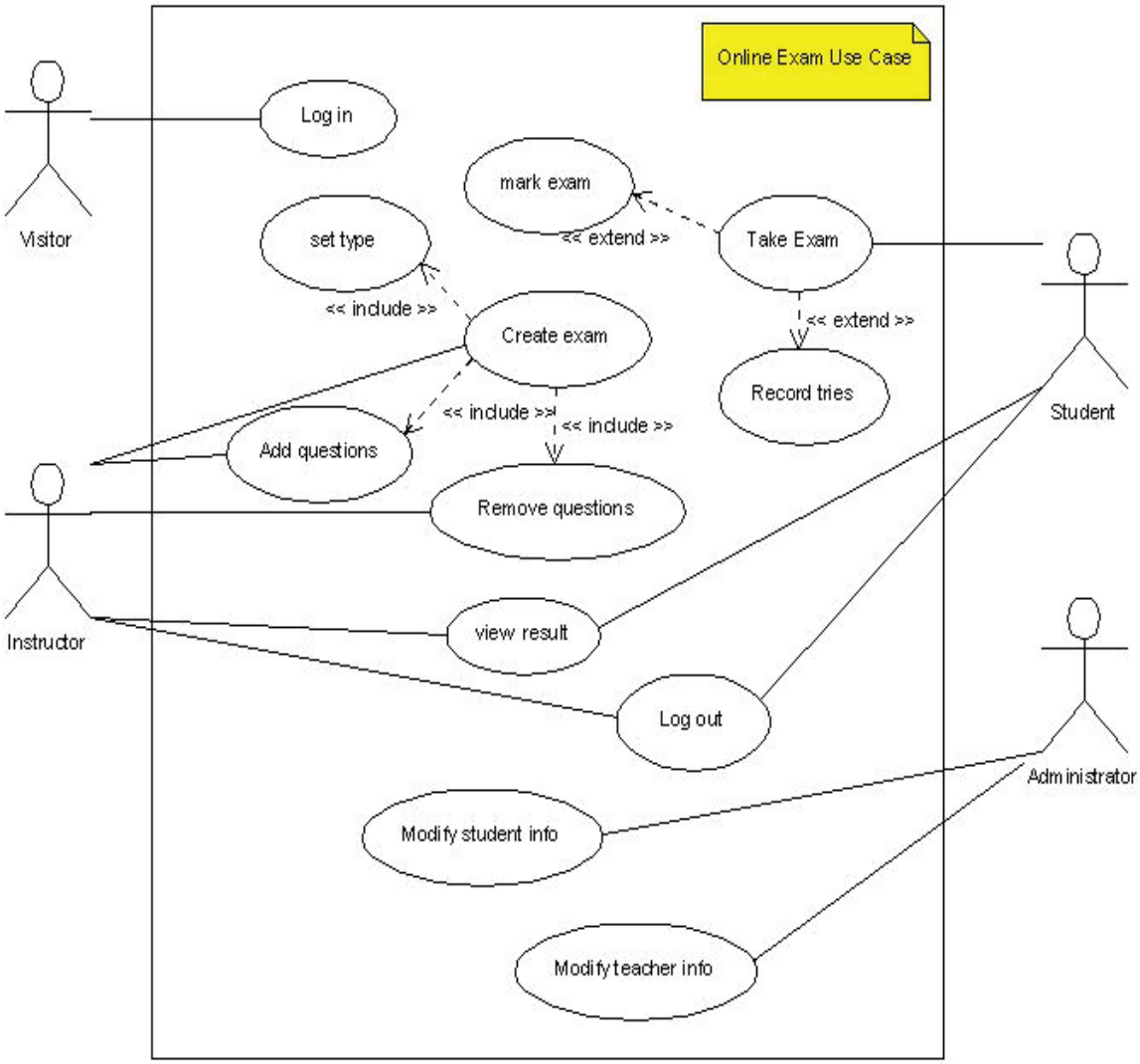

Figure 1. The generalized use case diagram of proposed system

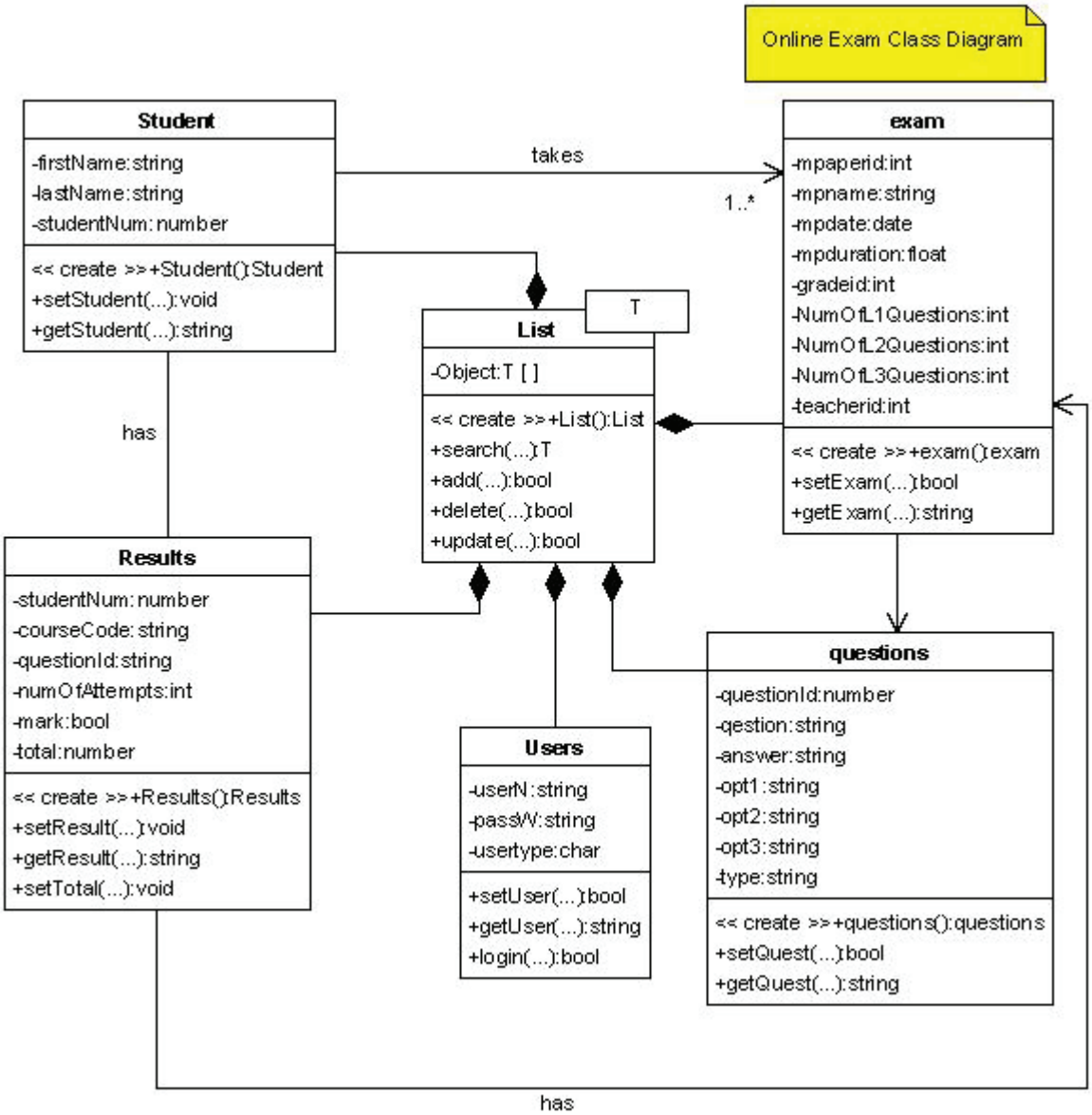

Figure 2. The class diagram of the proposed system

4. General Structure of Genetic Algorithm

A genetic algorithm is a search technique used in computer science to find approximate solutions to optimization and search problems. Specifically it falls into the category of local search techniques and is therefore generally an incomplete search. Genetic algorithms are a particular class of evolutionary algorithms that use techniques inspired by evolutionary biology such as inheritance, mutation, selection, and crossover (also called recombination).

Genetic algorithms are typically implemented as a computer simulation in which a population of abstract representations (called chromosomes) of candidate solutions (called individuals) to an optimization problem evolves toward better solutions (mathematics performance). The evolution starts from a population of completely random individuals (tests) and happens in generations. In each generation, the fitness of the whole population is evaluated, multiple individuals are stochastically selected from the current population (based on their fitness), and modified (mutated or recombined) from a new population. The new population is then used in the next iteration of the algorithm.

5. Conclusion and Extensions

The proposed web-based solution is a part of a project supported by Ministry of Education in Northern Cyprus. It is going to be applied in primary schools to check and improve mathematics performances of mainly fourth graders. The possible extensions of this solution can be the followings;

i) It can be modified to check and improve the language performances of students
ii) The integration of this system to a Geographic Information System (GIS)

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